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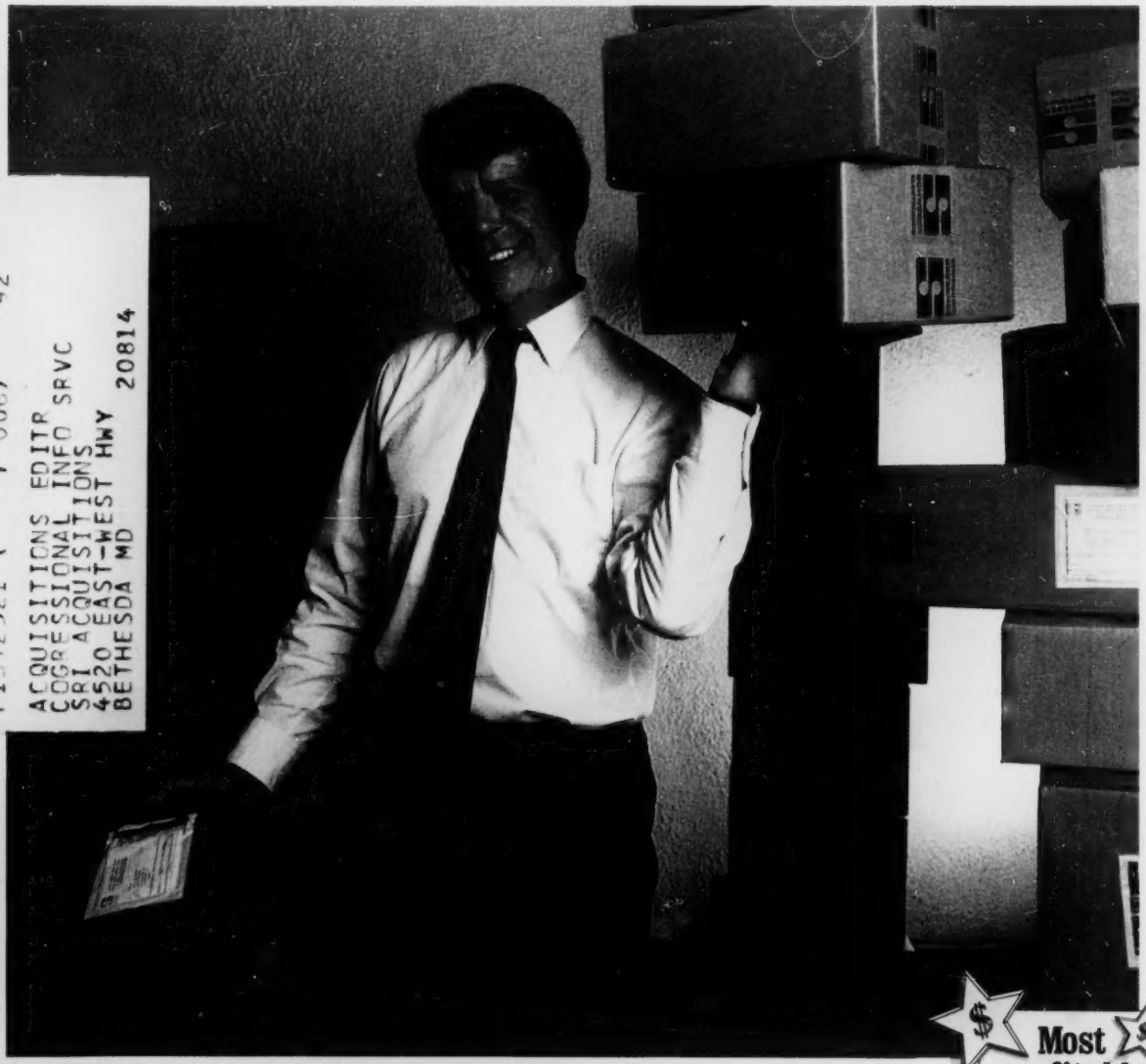
Electronic Business

Graphics terminals: Strategies for future growth

Semiconductor production: Mini-fabs reshape the market



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Most profitable electronics companies

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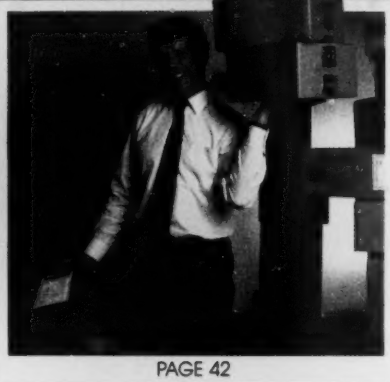
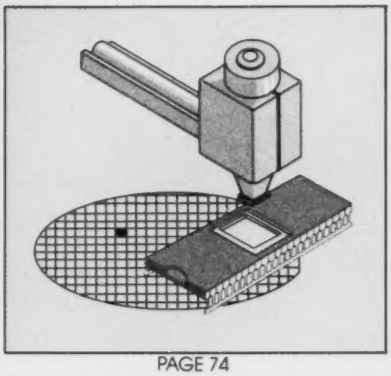
PAGE 33



PAGE 42



PAGE 74

BUSINESS TRENDS

30 Seoul sourcing: Nationals demur as regionals jump in
Korea's chip makers want stronger U.S. distribution networks. But they're not getting it yet.

33 Super hot interest in super cold materials
Newly discovered ceramics have spurred interest in superconductivity. But applications are years away.

38 The rise of Taiwan's PC board industry
In an effort to boost U.S. sales, PCB makers in Taiwan are moving rapidly into multilayer technology.

MARKETS

60 Top-to-bottom changes in graphics terminals
The graphics terminal industry is undergoing some fundamental changes at both the high and low ends.

68 Mainframes: Lowdown on the slowdown
Power-packed minis and micros have stalled mainframe growth. But there are compatible bright spots beyond Big Blue's hue.

DISTRIBUTION

42 Schweber's plans require both growth and profits
Backed by a wealthy parent, the No. 3 distributor has revamped operations and looks to regain profitability.

FINANCE

94 The most profitable companies of 1986
Despite all their complaints, makers of computers and computer products paced the 1986 electronics industry.

AN EDITORIAL INDEX OF ALL COMPANIES DISCUSSED IN THIS ISSUE CAN BE FOUND ON PAGE 110

PRODUCTIVITY

74 Mini-fabs reshape IC production
The rise of small lot chip manufacture has forced changes in fab design, construction and equipment.

80 How Computer Products linked MRP to AS/RS
HP and ASK Computer provide a Florida power supply firm with a host of manufacturing solutions.

DEPARTMENTS

4 Inside Business

9 Update

17 Business Barometer: Like IBM's new PCs, the future is ASICs.

24 Executive Viewpoint: Mentor Graphics' Gerald Langeler on spinning off a high-tech subsidiary.

26 Letters

100 Comment: Rapid growth, fast retreat: A way to stay on top.

108 Calendar

110 Editorial Index

112 Viewpoint: European firms must find strength in alliances.

Cover photo/Jonathan Levine

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Like IBM's new PCs, the future is ASICs

As computers demand ASICs, the trade tiff increases DRAM prices. More dollars for semis

"We've surrounded Intel's [microprocessors] with IBM's custom logic," said William Lowe, president of IBM's Entry Systems Division, last April when he introduced Personal System/2, the company's new generation of personal computers. Taking the covers off some of the new machines, Lowe's people expose a motherboard showing neatly arranged rows of standard looking memory chips and three or four very big ICs. The memory chips may look standard but aren't — they are 1 Mb DRAMs that IBM makes in Essex Junction, Vt. As for the large ICs, all packaged in pin-grid arrays of 42 leads and up, they also bear IBM markings. One of them is an Intel microprocessor (8086, 80286, or the new 80386, depending on the computer model), the others are custom CMOS logic chips that IBM makes in Essex Junction and in East Fishkill, N.Y. By coalescing so much logic into custom chips, IBM has not only saved money on ICs and real estate on its printed circuits, but has made it more difficult for would-be competitors to clone the new computers.

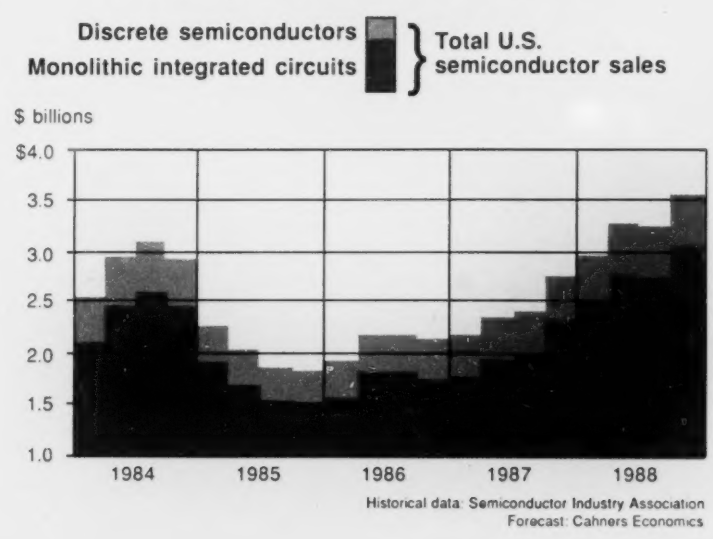
If, as IBM hopes, the machines sell, it will keep not only its captive semiconductor fabrication busy but also the merchant makers of application specific ICs, especially in CMOS. Not surprisingly, two of the Personal System/2 machines delivered only one week after their introduction went to ZyMOS. Daewoo, the Korean company that makes the Leading Edge "D" clone of IBM's PC AT, owns 56% of this Sunnyvale, Calif., manufacturer of ASICs. ZyMOS has no orders yet from its Korean parent, says marketing vice president Dave Guzeman, but knows that Daewoo as well as other clone manufacturers must duplicate IBM's move into ASICs to stay competitive. Presumably, most of these competitors will try to clone at least the new version of the PC, IBM's model 30. Zenith Electronics, for one, already uses ZyMOS' ASICs for its AT clone.

CMOS and bipolar ASIC sales to manufacturers of computers of all sizes are providing welcome relief for semiconductor makers. "Cray, DEC, and Tandy use Motorola's bipolar gate arrays," Charles Thompson, worldwide marketing director of Motorola Semiconductor Products, says with no small pride.

The Semiconductor Industry Association reports that total semiconductor shipments to the U.S. market increased by 5.2% (in dollars) in 1986, and gained strength in the first quarter of this year. Analyzing these figures, market researcher Jack Beedle of In-Stat provides a very perceptive view of where this growth took place in 1986. Most of it was in discrete semiconductors, which increased shipments by almost 7%. ICs grew only by 4.8%. Not surprisingly, the IC growth star in the United States was CMOS, 40.6% (many of them from ASICs shipments), followed by analog ICs with 18%. MOS logic (other than CMOS), dropped 6.9% and, as expected, MOS memory fell 18.3% in dollars, mostly because their prices were off almost 10% with respect to 1985's. However, prices of 64K and 256K DRAMs firmed up considerably in the first quarter of this year, as a reaction to the U.S. government's sanctions against Japan, and in response to that country's announced intention to curtail DRAM production. If these price increases stick, the total U.S. semiconductor market could grow even more than the 15% that Cahners Economics forecasts for 1987.

ALBERTO SOCOLOVSKY

U.S. semiconductor sales



Historical data: Semiconductor Industry Association
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. The fourth quarter was up 0.7% from the prior quarter bringing yearly production up 1%. This year, modest gains are expected to continue through midyear with sharper increases in industrial production expected in the third and fourth quarters.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 104.1 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 4.1% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

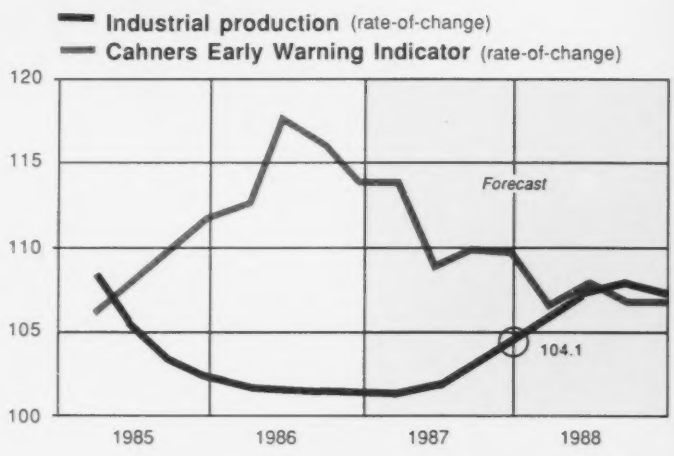
Defense and space equipment

Reductions in military spending authority in fiscal 1986 and 1987 have begun to take the steam out of the defense boom. Many programs have been stretched out, causing growth in military-equipment production to slow to a modest 4% to 5% year-to-year rate down from a 10% rate just 12 to 15 months ago. The budget will continue to be squeezed in fiscal 1988 and beyond as Congress fights to reduce the federal deficit, bringing a further moderation in defense market growth. Production, which showed an unexpectedly strong 2.4% gain in last year's fourth quarter, grew an estimated 5.6% in real terms for all of 1986. The pace of growth is expected to slow to just 4.8% this year and 1.6% next year.

Aircraft and parts

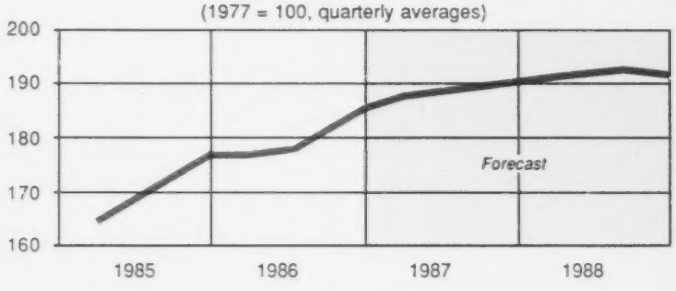
Aircraft production increased 2.5% in last year's fourth quarter compared with the third quarter and posted a gain of 12.3% (in real terms) for all of 1986. This was the industry's strongest growth performance in seven years. Most of the increase was attributable to expansion in the military aircraft market, which is being boosted by carryover spending from past defense budgets. Recent budgetary actions are likely to dampen growth in this segment of the industry over the next several years. Despite a comeback in the nondefense market, overall production of aircraft and parts is expected to post a moderate 6.1% gain this year and then to dip approximately 0.7% next year.

Economic indicators



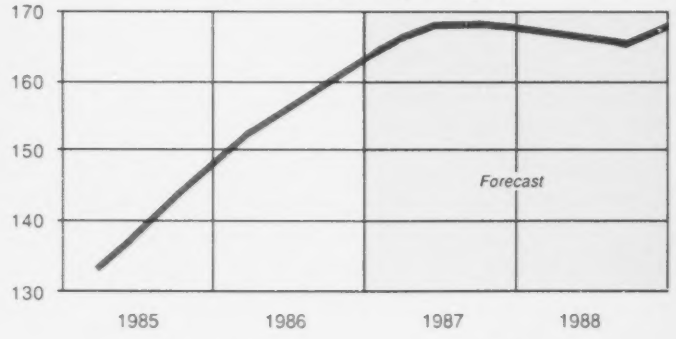
Industrial production: Defense and space equipment

(1977 = 100, quarterly averages)



Industrial production: Aircraft and parts

(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Seoul sourcing: Nationals demur as regionals jump in

Korea's chip makers want stronger U.S. distribution networks. But they're not getting it from the big boys

Describing the U.S. sales success of Korean chip makers is a bit like the old attitude test. Is the glass half full? Sure: they have won stellar sales in two short years. Or half empty? They have yet to secure a major original equipment manufacturer (OEM) order or a national distribution franchise.

Selling about $60 million worth, or 0.6% of all semiconductors bought in the United States last year, hardly qualifies the Koreans for the big time. Neither does their strength in memory product, where they captured under 2%, keep Motorola Inc. salesmen awake nights.

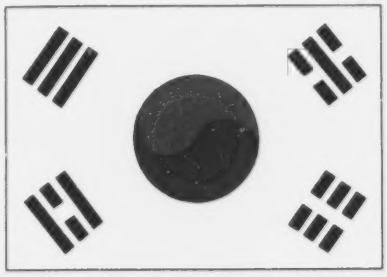
But they only began selling in 1985. This year, U.S. sales of the Califonia-based Big Three — Goldstar Semiconductor Ltd. in Sunnyvale, Hyundai Electronics America and Samsung Semiconductor Inc., both in Santa Clara — should reach $185 million, or 1.6% of total, while their memory chips could run off with a 4% share.

Distribution is pivotal to further gains. While credibility will soar if Seoul-sourced chips are designed into a big OEM's new product, good distributors will open a broad customer base. That is why these three, like the Japanese seven years ago, have lost no time in forging what distributor liaisons they can. Samsung sells through 40 local industrials nationwide. Hyundai has about 25. Even low-profile Goldstar can lay claim to 10. (Daewoo, the fourth member of Korea's *chaebol*, or industrial-conglomerates club, acquired custom-chip maker Zymos Inc. last fall but sells no Korean-made product through distribution.)

These small local and regional middlemen did the Koreans proud: last year they provided about 30% of their vendors' aggregate U.S. sales. "Well above plan," smiles Samsung distribution director Clyde Brewer. Order sizes remain small: typical for local distributors are the $15,000 to $25,000 deals. But they are gaining momentum: Santa Clara-based Cypress Electronics, a $34 million Western regional with seven stocking locations, recently clinched an $800,000 contract for memory chips from a computer-peripherals maker.

Pricing tactics

The Koreans' early inroads are due in part to their pricing, which often, but not always, comes in 5% to 10% lower than competitive product. And partly it's due to availability as other chip sources have atrophied. It also doesn't hurt that Goldstar TVs and Hyundai cars are proving popular.



This year, U.S. sales of the Big Three — Goldstar Semiconductor Ltd., Hyundai Electronics America and Samsung Semiconductor Inc.— should reach $185 million

But throughout, Japan's difficulty has been Korea's opportunity: with Hitachi et al. under fire from U.S. chip makers and lawmakers alike, increased fair market value prices, as determined by last year's U.S./Japan chip accord, are forcing Japanese chips off the shelves and out of the market.

So far, two-thirds of the Koreans' offerings have been memory product: 64K, and increasingly, 256K dynamic random-access memory (DRAM) chips. The biggest and boldest contender, Samsung, is about to begin selling a 1-megabit (Mb) DRAM. About 70% of its distributor sales come from memory devices, but the goal is to get half from other products, like its transistors, some linear circuits, logic chips and electrically erasable read-only memory (EEPROMs), and from new lines, like power metal-oxide semiconductor field-effect transistors (MOSFETs) and standard EPROMs.

Hyundai, which observers say trails the aggressive Samsung by about a year, is still ramping up its 256K DRAMs while preparing a 1Mb DRAM. Goldstar, further behind still, is marketing only logic chips.

However, to claim that the Koreans have cracked U.S. distribution markets would be like saying Hyundai's subcompact car rips through the quarter-mile in 10 seconds. The full franchises with top-tier houses — the ones that would signal that the Koreans had really arrived — remain elusive. "We believe we need a couple of strong national distributors. We're doing everything to get them and having a hard time at it," admits Brewer.

It's not hard to see why. The big industrials fear reprisals from their U.S. chip suppliers — and even from Japanese vendors. Talk to Howard Franklin, president of Bell Industries Inc.'s Electronics Marketing Group, and others. The answer is the same: they are not about to lose existing chip franchises.

And for what? Several top-line distributors contend that the Korean product's quality is far from proven, a charge the Korean vendors — and their local distributors — quickly refute. Others are not tempted by limited product: memory chips do not a full range make. Some simply say that full pipelines from existing suppliers make other brands redundant.

Marshall Industries marketing vice president George Tarnawsky offers another perspective: he figures that distributors will get burned if the federal government turns today's Japan-bashing binge into attacks on Korean product pricing. "So why jump into something if that something is going to be short term?" he asks.

Interestingly, that didn't stop industry leader Hamilton/Avnet, a division of Avnet Inc., from inking a "purchasing agreement" with Samsung last fall. Caught with acute shortages of 256K DRAMs from domestic suppliers like Motorola, Hamilton/Avnet opted to buy Samsung 256K DRAMs on a selective basis.

Samsung is delighted with the linkup. Says distribution manager Brewer: "It has done a very nice job for us." Hamilton/Avnet refused to return repeated phone calls about the dalliance which several competitors view as a thinly disguised franchise, not the simple purchasing agreement Hamilton/Avnet insists it is. "If it walks like a duck and quacks like a duck, then it's at least a drake," quips Stephen Kaufman, president of Arrow Electronics Inc. "I guess what they're trying to do is become half pregnant," adds Marshall's Tarnawsky.

The reaction of small regionals that carry Samsung is less predictable. Far from feeling abused, many praise the pact for raising the profile of the Korean lines. "We're happy to see it happen. It gives the line a lot of validity," says Arthur Nyblin, founder of QPS Electronics Inc., a new distributor serving Chicago and expecting nearly a third of its $3.5 million in sales to come from Korean chips.

But what major national franchises will not do is give the Koreans 100% share of mind. Which is why Samsung's Brewer, for one, is keen to continue using "Mom and Pop" distributors too.

Indeed, it is clear that there's a whole lot of using going on. The Korean chip makers are clearly using second- and third-tier distributors until they can get big-league industrials to be their front-runners. "Upgrading the quality of our distributors," is how it is billed.

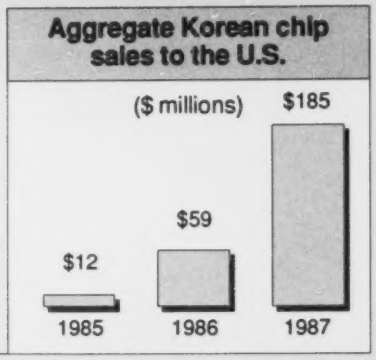
Not that the little guys seem to mind. They're busy exploiting back, many of them using Korean product to diversify out of soggy electromechanical or passive components and into lucrative and sexy semiconductor sales. Admits one: "If I had the opportunity to take a Motorola line, I would give up the Samsungs of this world readily."

There's plenty of education to go with the mutual exploitation. Edward Kramar, president of Cypress Electronics, believes he was lucky to hook up with the Koreans so that he could learn how to handle chips without the pressure that a Japanese franchise might have put on him.

The Koreans have used their new allies to uncover the secrets of distribution. According to several sources, the chip makers of Seoul, like the Japanese before them, were somewhat naive when it came to the nuances of return policies and stock rotation practices. They also took some time to relax credit procedures that were tighter than U.S. distributors were accustomed to. The Korean companies were initially demanding payment

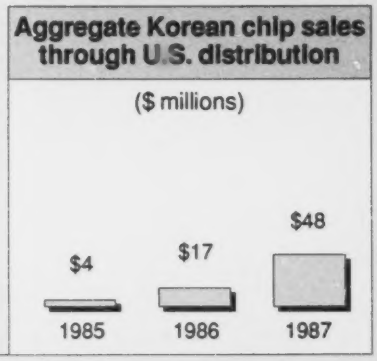
Korean semiconductor sales in the U.S.

Korean chip sales to the U.S. are still tiny. . .



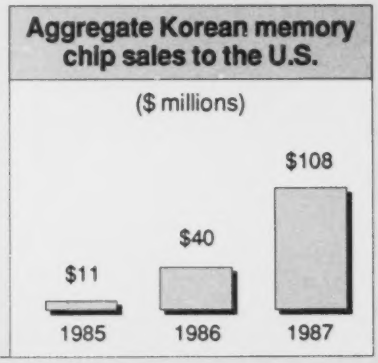
Percentage of total market	0.12%	0.58%	1.62%

as distributors play their part. . .



Percentage of total market	0.17%	0.64%	1.56%

but the gains are faster in memory semiconductors



Percentage of total market	0.51%	1.96%	4.37%

Source: Dataquest Inc.; industry and ELECTRONIC BUSINESS estimates

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from distributors in 10 days — "pretty much impossible to do," says William Cassel, marketing vice president of Schuster Electronics Inc. in Cincinnati — and shutting off supplies promptly after 30 days if still not paid.

But they have learned fast. One of the key lessons cited by Jae Y. Park, Hyundai's national sales manager, is that America is unique in terms of serving the customer. "It's not the sales channel which tells us what to do — it's really the customer," he says. Park also notes the need not merely for availability of good product, but for good ongoing relationships with distributors.

Samsung learned early to use experienced American marketing managers, a talent that has clearly stood it in good stead. And it has adeptly tapped the gray market, selling 10% to 20% of its non-OEM chips through nonfranchised brokers at discount prices.

Many small franchised distributors, paying more and charging more for Korean product in return for full price protection and other franchising advantages, criticize this practice. "A traitorous, petty measure" says one. Samsung's Brewer, however, defends the approach: "Those guys [the brokers] were the only guys that had a great interest in us at the very beginning. And they really know the memory business," he says.

> Korean electronics companies would prefer to be seen as trading partners, not as rapacious raiders

In gray markets, Samsung's 256K DRAMs with 150 nanosecond speeds sell for as little as $1.63 in 10,000-part buys. Less than their Japanese equivalents? "Oh, God — incredibly less! We'd be lucky to get [the Japanese chips] down to $1.90," exclaims a saleswoman at broker CAL-ABCO Inc. At another broker, Centon Electronics Inc. in Irvine, Calif., the same chips come in 20 cents cheaper than Japanese equivalents.

Marginal existence

While the brokers may be happy to make skin-thin gross margins, the franchised distributors want at least 25%. And they are getting it. Margins are acceptable: QPS in Elk Grove Village, Ill., for instance, makes up to 35% on its Korean semiconductors.

Pricing is not quite the issue many think it is. The Koreans are not anxious to attract any of the government spotlight they so fortuitously take advantage of right now. "We're trying desperately to maintain prices. We're trying to stay out of the eye of the federal government, so we're staying very clean. We're very sensitive to that issue," says Samsung's Brewer.

For all their rapid progress, the Koreans have been noticeably cautious in approaching the U.S. market. "They turned out not to be the aggressive giant-slayers we had hoped for," says Cypress chief Kramar. Put that down to their not realizing how strong the Japanese hold on the market was, and how much long-term commitment distributors have to vendor relationships.

There is also a desire not to goof up. "In the U.S. market, first impressions are very important. Before starting, we need some experience in quality," says Goldstar sales manager H.S. Yoon, pointing out that his chips are being tested exhaustively in the Far East before being released for sale here.

While plenty depends on the outcome of the Japanese trade restraints, the consensus appears to be that Korean chip makers are here to stay. "I think they're a force to be reckoned with. They bring more to the party than low prices: they bring quality and financial strength," says Tony Cucchi, president of Philadelphia-based multiregional distributor Almo Electronics Inc., where pricing problems with Japanese DRAMs and EPROMs have slashed growth plans and sparked interest in the Korean chips.

The Koreans themselves are keen to be seen having strong commitment to distribution channels, and to appear as strong second sources of commodity product. On the broadest level, they would prefer to be seen as trading partners, not as rapacious raiders: Hyundai cars already use U.S.-made glass, tires and carpets; the Seoul government also plans to import U.S. fossil fuels to redress its trade balance.

Therefore, conclude some semiconductor market researchers, national distributors would do well not to ignore the Koreans. Quoting Marshall as an example of a top-ranking distributor that rose from the second level on the back of aggressive marketing of Japanese chips, one observer hints that the reverse could happen to the big boys if they do not respond to market forces.

JOHN KERR

Top-to-bottom changes in graphics terminals

The graphics terminal industry is undergoing some fundamental changes at both the high and low ends

By David Card

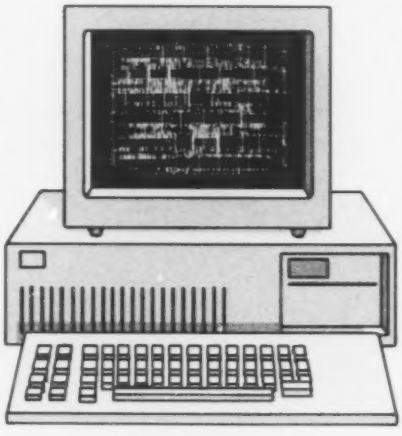
It is a familiar story. Yet another electronics market restructures as the cost of computing power shrinks. This time it is graphics terminals, where personal computers (PCs) are infringing on the low end and 32-bit graphics workstations move in at the top.

There is no future for "dumb" terminals — those with no local processing power — says Carl Machover, president of graphics market-watcher Machover Associates Corp. in White Plains, N.Y. Even IBM terminals are being overtaken by PCs, he says. However, Machover says that it is premature to say that a graphics workstation is the only way to go at the high end. Likewise, Dataquest Inc. analyst Michael Tyler out of San Jose, Calif., says, "the jury's still out" on the issue of standalone computers versus terminals in many graphics applications.

The price advantage that terminals enjoy over computers and the ease of controlling a company database on a large host are two factors favoring the survival of graphics terminals, Tyler says. But, he forecasts that next year unit sales of PC graphics boards that compete with low-end terminals will outstrip terminal sales for the first time.

At the low end, terminal leader Tektronix Inc. finally got tired of start-ups writing software for PCs to emulate Tek's industry-standard terminals. So, in March, Tek signed up one of those start-ups, Grafpoint, to write the software for a Tek package that includes a Tek-built add-in board and a monitor from Sony Corp. Just months before, Tek also introduced a new line of graphics terminals with price tags as low as $3,000, a 40% to 65% price cut over comparable models. According to Jon Reed, vice president and general manager of Tek's Information Display Group in Wilsonville, Ore., Tek only went into PC graphics to keep its current customers. Many of them were buying PCs by the truckload.

Among noncomputer companies, Dataquest ranks Tek as the leading independent graphics terminal producer. Tek has always aimed its terminals first at Digital Equipment Corp. computers, and DEC does resell some Tek terminals. So it was a blow when DEC's workstation, the VAXstation series, came out last year with DEC terminals sitting on top of them. Reed says that this is nothing new — DEC's hosted graphics line, including its VT200 and 400 terminals, always competed with Tek's. "The upper end is where it's changing," Reed admits.



"IBM is the only place terminal makers have a future because DEC *will* be a workstation company"

Gary Meredith of Evans & Sutherland

And changing it is. "A lot of people won't talk to you without a workstation," says Gary Meredith, president of the Interactive Graphics Division of Evans & Sutherland Computer Corp. in Salt Lake City. Meredith claims that McDonnell Douglas Corp.'s fighter plane unit is his biggest customer, buying some 300 to 400 three-dimensional terminals a year. Yet other McDonnell divisions buy graphics workstations from Silicon Graphics Inc. (SGI) of Mountain View, Calif. Silicon Graphics president Edward McCracken also calls McDonnell his largest customer. So Evans & Sutherland signed an agreement with DEC to team up on an ultra high-end graphics workstation.

Meredith claims that between DEC doing its own midrange graphics and the joint effort on the high-end workstation, the DEC market has dried up. "IBM is the only place terminal makers have a future because DEC *will* be a workstation company," Meredith says. Until the new model comes out later this year, there is nothing to preclude people buying a $20,000 VAXstation and sitting a $47,000 Evans & Sutherland terminal on top, he adds. Meredith says that his division had nearly $50 million in sales last year.

Tektronix's Reed says that Tek has always shunned the upper end of the market, preferring to stay away from $50,000 terminals. Tek got into the graphics business in the early '70s, and Reed credits his installed base and de facto standard software routines for Tek's staying power. A newer realm is the PC add-in board that Reed initially expects to sell into that

base. But other Tek marketing managers estimate that Tek will have to generate as much as 85% of its board sales through channels other than its direct salesforce.

Niche strategies

Most graphics terminal companies do not have the luxury of the Tektronix lineup, which includes intelligent terminals incorporting 16-bit chips from Intel Corp. and 32-bit workstations as well. Tek also does a quarter of its estimated $400 million graphics business in digitizers and color printers. Most companies are developing niche strategies.

But Seiko Instruments U.S.A. Inc. is not most companies. The U.S. subsidiary of the Japanese company, which owns as much as 70% of the Japanese graphics market, is going all out, Dataquest says. "Everyone is saying the world is heading to the point where everybody is going into niche markets because they can't compete," says Andrew Wei, division manager of the Graphic Devices and Systems division in San Jose. "We believe differently." Seiko U.S.A.'s sales mix is the reverse of Tek's, with 70% to 80% of its sales coming from printers and other peripherals. But Wei wants to make it 50-50 for terminals, and he comes close to admitting that he is willing to buy market share. "You can't look too long at a quarterly profit to get there," Wei says.

But the two analysts say that Seiko has yet to be successful in the United States. Wei admits Seiko is "still in the process of getting the user to rewrite his software" to support Seiko graphics. Seiko has so far stayed pretty much in the middle performance range, and Wei is not aiming at the high end, yet. He believes more money can be made selling terminals and add-in boards to the next generation of PCs. But, he says: "The next big question over the next three years" will be whether Seiko puts a central processor-type chip into its terminals.

"There are those who say the days of the host-dependent terminal are dead. Well, that's not true. There are an awful lot of MicroVAXes being sold," says Joseph Morris, vice president for marketing for Ramtek Corp. in Santa Clara, Calif. Morris attaches three or four terminals to a 32-bit MicroVAX from DEC and dares workstation makers to compete on a cost-per-seat basis.

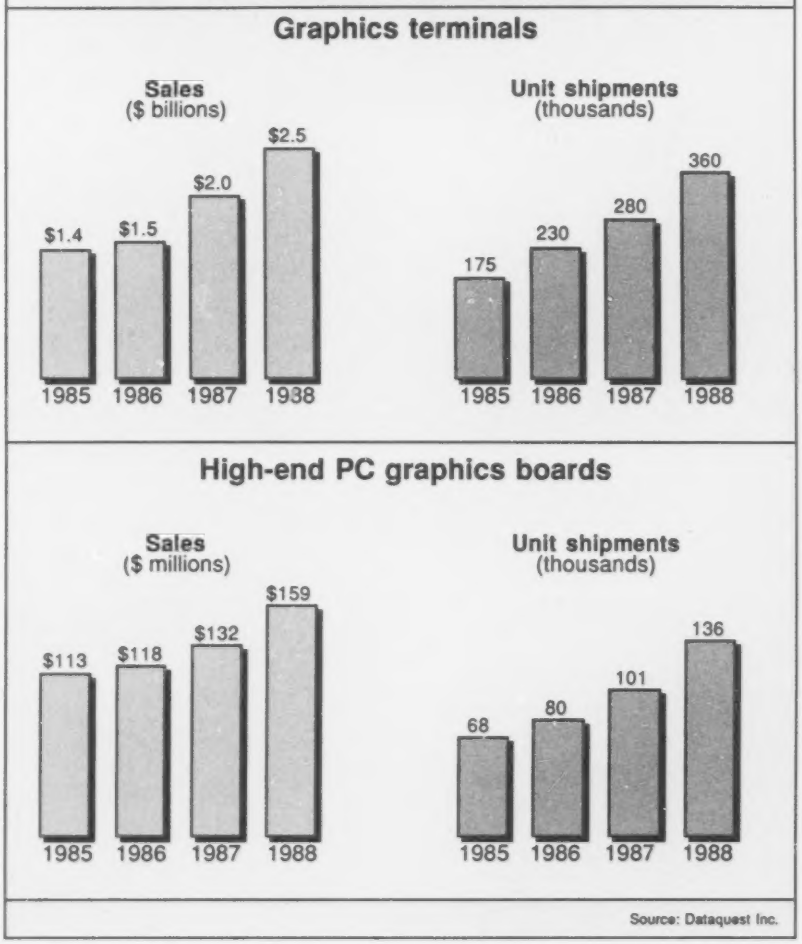
Ramtek also has two distinct tracks for its terminals — graphics and imaging. Ramtek sells into applications such as satellite mapping where images are based on real life rather than completely computer generated. Tyler of Dataquest says that Ramtek is particularly adept at combining graphics with images, especially, for example, in a weather map where the topographical map overlays a satellite photo.

A focused approach

One advantage of the focused approach is an easily identified customer base. "I don't have to go out and count smokestacks," Morris says, "You can tell who the customers are." Aerospace and petroleum companies, and government agencies such as the National Aeronautics and Space Administration (NASA) are customers.

Ramtek, however, is only just starting to see the benefits of its focus. The company has been losing money for two years — $2.1 million on sales of $39 million in fiscal 1985 (ending

Worldwide market for graphics terminals and high-end PC graphics boards



Source: Dataquest Inc.

June 30); $15.3 million in losses the previous year. Last July, Ramtek sold off a subsidiary that was trying to get into the movie animation business. Ramtek has since turned profitable again.

United Telecommunications Inc. subsidiary Megatek Corp. of San Diego does not release sales figures, but analyst Machover estimates Megatek sold some $40 million worth of its high-end terminals. Megatek Graphics Systems vice president Patrick O'Brien characterizes the graphics business of the last three or four years as one plagued with turmoil. "We have stayed alive because of our high-end focus," he says. "And it never hurts to have a strong parent."

O'Brien continues: "The burning question is: Why do we think we will be successful [against] the emerging market for workstations?" Megatek's answer is to keep up at the high end — moving 3-D, shaded solids — and bet on the cost per seat and database arguments. O'Brien says that a workstation is not in his immediate plans, unless one of his large customers like Hughes Aircraft Co., Ford Motor Co.'s Aerospace division or Northrop Corp. demands it. Even so, Megatek already incorporates Intel's 32-bit 80386 microprocessor in its intelligent terminals.

O'Brien is also quick to point out "a new characteristic of the emerging Megatek — very aggressively priced products." Megatek's full range runs from $22,000 to $57,000 in price. O'Brien says that he can keep costs down via the latest in new design technology. Megatek was a beta site for Silicon Compilers Inc. (now called Silicon Compiler Systems Corp.), using its computer-aided engineering (CAE) systems that allow systems designers to design custom chips. □

The rise of Silicon Graphics

One company causing major headaches among high-end terminal makers is 6-year-old Silicon Graphics Inc. of Mountain View, Calif. Silicon Graphics had $41.5 million in sales last fiscal year (ended June 30) and $34.7 million the first six months of fiscal 1987, often at the expense of the more traditional graphics companies.

Silicon Graphics designs its own graphics chip set, but relies on other companies for its central processor. Its first workstations, in the $50,000 to $75,000 price range, contain the same Motorola Inc. chips that are the guts of general-purpose workstations from Apollo Computer Inc. and Sun Microsystems Inc. For the new model, SGI went to a reduced instruction set computing (RISC) chip set from start-up MIPS Computer Systems Inc. Silicon Graphics president Edward McCracken says that the founders of SGI, MIPS and Sun all graduated from the same class at Stanford University.

McCracken says that Prime Computer Inc. convinced SGI to forego the next round of Motorola chips and skip directly to MIPS Computer, throwing a little cash both companies' ways to encourage things. Prime now resells the SGI/MIPS machine as its workstation offering.

So will Control Data Corp., which also resells the earlier SGI workstation. SGI's 3-D graphics are the best of the workstation lot, according to E.E. Randoll II, general manager for computer-integrated manufacturing (CIM) marketing at Control Data. CDC needed such performance so that both electrical and mechanical design could be done on the same workstation. SGI's McCracken is hoping to use this to crack the mechanical engineering departments of the other two Big Three auto makers — he already claims General Motors Corp. as a customer. He says that Ford Motor Corp. is a Prime house; and Chrysler Corp., a CDC shop.

SGI's PRESIDENT EDWARD McCRACKEN: His company went to a RISC chip set from start-up MIPS Computer Systems for its new model workstation

Tektronix Inc. vice president Jon Reed says that SGI's workstations are similar to Tek's 4400 line, which only uses 16-bit chips from Intel Corp. "Frankly our machines don't compare," Reed says. Tek has a 32-bit workstation, but Tek's own design automation division opted not to support it, casting doubt on its life span.

Reed cautions that the arrival of companies like MIPS may not be all good news for SGI. The "amazingly cheap MIPS [millions of instructions per second]" that such companies offer make it easy for graphics companies to stay away from the computer business and concentrate on graphics. Reed says that Tek is very interested in the under-$50,000 graphics workstation business and hints that a deal with a major player is cooking. He had better hurry up, McCracken says. Of the big workstation companies, Apollo traditionally does its own high-end graphics, as does Hewlett-Packard Co.; Prime and CDC are taken; Sun has a reference-selling deal with General Electric Co.'s graphics division, and Digital Equipment Corp. is teamed with Evans & Sutherland. □

Mainframes: Lowdown on the slowdown

Power-packed minis and micros have stalled mainframe growth. But there are compatible bright spots beyond Big Blue's hue

By Anne Knowles

Mainframe market growth slowed to single digits last year and will only get worse before it gets better, say industry analysts. In 1986, worldwide mainframe revenue for U.S. vendors rose 3.4%, to $17.55 billion, according to International Data Corp., a market research firm in Framingham, Mass. This year, mainframe sales should be flat, says Frank Gens, an analyst with IDC. And in 1988, predicts Steven Milunovich, an analyst with First Boston in New York City, IBM's mainframe sales — which make up nearly two-thirds of the market — could drop by 10%.

Many analysts believe the days of double digit growth in the mainframe arena are gone forever. Mainframe sales are being sapped for a number of reasons First Boston's Milunovich says there is a shift away from buying large processors to purchasing smaller systems, including low-end mainframes, with smaller price tags, and superminis, which are sold by more vendors in a more competitive marketplace. While mainframe sales remain stagnant this year, sales of personal computers and minicomputers should rise about 10%, says IDC's Gens. "Minis are acting as a siphon on new mainframe demand," says Gens.

> The mainframe market is suffering from lack of adequate software

The siphoning action is distributing processing power across a number of systems rather than centralizing it on mainframes. Since the advent of 32-bit desktop computers, with more raw processing power or millions of instructions per second (MIPS), end users can fulfill computing requirements with smaller, less expensive systems that have better price/performance ratios than their larger brethren. Across IBM's product line, for example, the cost per MIPS increases as the number of MIPS on a system increases, says Kimball Brown, an analyst with Dataquest Inc., a market research firm in San Jose, Calif. Customers are opting to buy smaller machines that provide more bang for the buck.

In addition, the mainframe market is suffering from lack of adequate software. "The slowdown has been caused by [a lack of available software] applications to utilize existing products," says Fred Meier, vice president for corporate management at Unisys Corp. Most analysts agree. "The software tools to develop applications haven't advanced as quickly as hardware technology," says IDC's Gens. "Until there are major technological improvements in tools it's not likely we'll see a return to high growth."

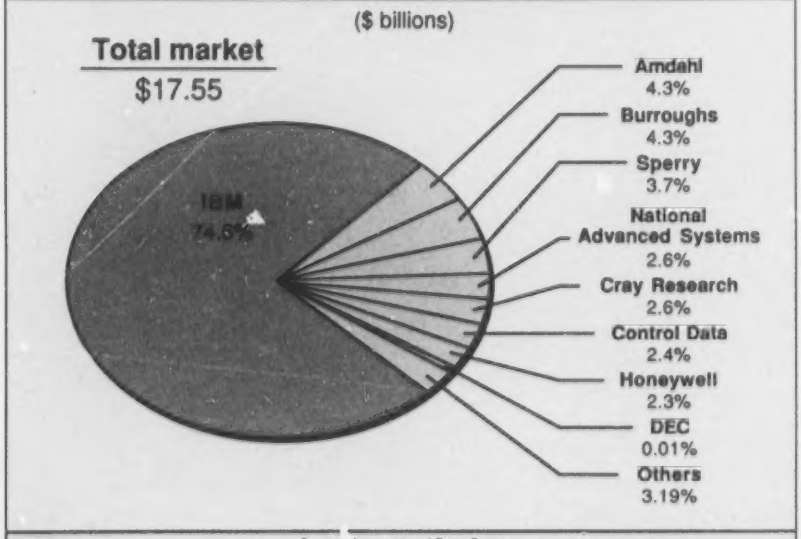
But even if that were to occur, agree most analysts, the mainframe's heyday is over. "I don't see it ever coming back to 20% growth," says Dataquest's Brown.

IBM's mainframe reliance

This is certainly bad news for IBM. Big Blue reportedly relies on mainframes for 25% of total revenue — which was $51.25 billion last year — and 50% of net income — which was $4.79 billion in 1986. This year, estimates the Yankee Group in Boston, shipments of IBM's 3090 series, the company's latest generation of mainframes commonly called Sierra, will drop 20%.

In January, IBM upgraded existing 3090 models with its E series processors. The result, says First Boston's

Mainframe market remained Blue through 1986



Source: International Data Corp.

Milunovich, was a 10% increase in performance with no decrease in price. The lack of price cuts on the new systems, says IDC's Gens, reflects a fundamental slowness in demand. "IBM sees that cutting prices is not increasing demand," says Gens. "IBM is entering a period where there will be one or no price cuts a year."

That slackening of demand effects IBM more than other mainframe players. Concerning the market, says Gens: "IBM needs strong growth in all sectors." This is needed to fuel a significant rise in its sales, he concludes. Reportedly, a number of IBM's largest accounts are holding back on purchases. And that alone is having a negative impact on IBM's mainframe business and seemingly on the market.

Because when IBM suffers the entire market appears to falter. Even though demand has slowed in the mainframe market, today there is "spotty sluggishness," says IDC's Gens. Because IBM commands almost 75% of the market, Big Blue serves as a barometer for business. But that can be misleading.

Plug-compatible sales

IBM plug-compatible makers (PCMs) are expected to quadruple their combined shipments of mainframe systems this year. Amdahl Corp., Sunnyvale, Calif. — which designs its 5890 series of mainframes with components supplied by Fujitsu — is expected to ship between 250 systems and 300 systems in 1987. National Advanced Systems, the Mountain View, Calif., subsidiary of National Semiconductor Corp. — which buys its AS/XL series of mainframes from Hitachi — may ship close to 200 machines this year. Both Amdahl's 5890 line and NAS' AS/XL series are both comparable and compatible with IBM's 3090 family.

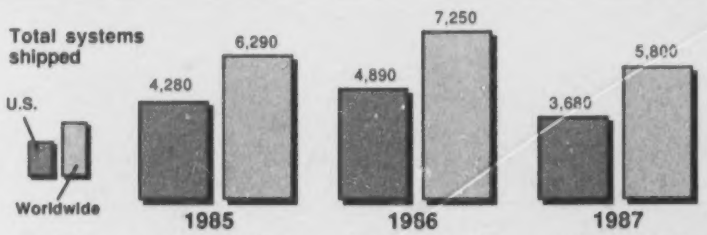
Demand is healthy for both Amdahl and NAS partly because both PCMs are in the midst of new product cycles. Amdahl first unveiled its 5890 series in October 1985 when the company introduced models 200, 300 and 600. In the beginning of this year, Amdahl added the uniprocessor model 190 and upgrades called the E series, to its other models. NAS also started out 1987 with additions to its AS/XL family, first introduced in 1985. Now the company has six AS/XL models — the 50, 60, 70, 80, 90 and 100 — which are comparable to IBM's 3090 200 and 400 in their range of performance.

Both Amdahl and NAS, according to company officials and analysts alike, have very attractive offerings. "We have a performance advantage over our prime competitor, which is IBM," says Wayne McIntyre, Amdahl's vice president for corporate marketing. Both Amdahl and NAS also have a price advantage; both Amdahl's 5890 models and NAS' AS/XL systems are 20% to 25% less than comparable IBM machines.

Mainframe buyers are also more likely now, says First Boston's Milunovich, to look at the PCMs' offerings. Both companies made it to market with their new generation of mainframes quicker than usual. In the past it has taken them up to two years to catch up with IBM; plug compatibles to IBM's 3090 series arrived to market a year after IBM's announcement. And many customers buy both IBM systems and an Amdahl or NAS machine to keep IBM honest, says IDC's Gens. "Our installed base, almost without exception, is also an IBM customer," says Amdahl's McIntrye.

But, the demand slowdown may catch up to the PCMs, too, by next year. Despite claims that hardware demand is robust, both Amdahl and NAS are in the process of diversifying their business' outside systems sales.

Slowdown expected in the IBM mainframe market



System	1985 U.S.	1985 Worldwide	1986 U.S.	1986 Worldwide	1987 U.S.	1987 Worldwide
4361	1,230	1,760	1,300	1,800	1,500	2,200
4381	2,200	3,200	2,300	3,300	1,100	2,100
308x	500	830	270	450	100	200
3090	350	500	1,020	1,700	980	1,300
Total	4,280	6,290	4,890	7,250	3,680	5,800

Source: The Yankee Group

> IBM is pushing products designed to utilize mainframes for newer, less traditional jobs

Amdahl's storage products division, which did not exist before 1983, last year accounted for 23% of sales, says McIntyre. Systems now represent 66% of revenue. The remaining 11% of sales is brought in by Amdahl's communications and software products. Amdahl, which does not offer in-house, or promote third-party, software applications, has a couple of R&D projects in process for software tools, designed to push processor performance, says McIntyre.

NAS, on the other hand, is focusing in on the engineering and scientific marketplace, particularly in the area of software applications. About 20% of NAS' systems sales go into that market, up from about 10% five years ago. Eventually, the company hopes to generate about one-third of its business in the scientific/engineering market. The impetus for NAS' directional shift is the company's vector processor add-on, similiar to, but reportedly twice as powerful as, IBM's vector processor, which gives mainframes the computer-intensive capabilities normally found on supercomputers.

To that end, NAS announced a software application development center in Atlanta this past March. There 31 software developers, formerly of Sperry Corp., will be developing both new applications and rewriting existing applications for the scientific/engineering user.

And IBM is pushing products designed to utilize mainframes for newer, less traditional jobs. NetView, initially announced a year ago with additions made last September, is a collection of five programs that manage networks tied into IBM main-

frames. IBM is also expected to announce more communications links to MS-DOS, the operating system for its personal computers; and a version of SQL, its mainframe database, to run on the PC and enable smaller IBM systems to more easily tie into large IBM machines. In addition, IBM, which declined to comment on future products, is expected to make a software announcement concerning VM, its mainframe operating system, by midsummer.

The pack's attack

Outside IBM and the PCMs — which combined account for nearly 82% of the mainframe market — the players are the same but the names are changing. Burroughs and Sperry, with a combined market share of 8%, are now Unisys Corp. The merged company stresses its commitment to both companies' line of mainframes — the 1100 family and the V series — and announced new systems, the V 510 and V 530, in March. And the combined company, according to analysts, is maintaining its lead in both the airline industry (traditionally Sperry's turf) and banks (Burroughs' previous domain).

In addition, Unisys revised its fourth generation applications system generator — LINC II — which Unisys' Meier claims increases programmer productivity 10 to 20 times. The company is also increasing both in-house and third-party software applications, says Meier. All of this activity, says Meier, represents, "a gradual trend toward software sales [and] away from hardware sales."

Honeywell Inc. which claimed 2.3% of the market last year is, as of last March, Honeywell Bull. Now owned jointly by Compagnie des Machines Bull of France (42.5%), Honeywell (42.5%) and Japan's NEC Corp. (15%), the company, according to analysts, has little impact on the mainframe market today. But that could change.

Dataquest's Brown believes Honeywell Bull could prove to be the wildcard in the future large-systems market due to NEC, which is supposed to up its ownership to 42.5% by year-end. Brown anticipates that because the company will not be tied to IBM through compatibility issues, it will be free to push price/performance ratios higher. That in turn, says Brown, will push IBM. "If NEC boosts the performance [of its mainframes]," says Brown, "it could pass IBM." He concludes: "It may force IBM to do a better job."

Honeywell is also pushing its systems as database machines through a joint marketing agreement with Teradata Corp., a maker of back-end database processors. In addition, says George Olson, Honeywell's vice president for large systems, the company will soon be making both hardware and systems software announcements. Among these, says Olson, will be database and fourth-generation language products and enhancements to the company's transaction processing product, TP8. Mainframes, says Olson, "are moving from batch processing to on-line, transaction-processing applications."

Another new name has appeared on the block. In March, Digital Equipment Corp. announced new VAX systems — the 8974 and 8978 — based on four- and eight-clustered VAXes, respectively. But analysts say DEC's new systems will have little, if any, impact on the mainframe market. Even DEC declines the comparison.

> The end user does not care whether it's a mainframe or a supermini or a workstation getting the job done
>
> Bill Askins of DEC

"People have been saying DEC is positioning itself against IBM's 3090," says Bill Askins, DEC's high-performance systems marketing manager. For DEC, says Askins, "that is somewhat suicidal." But, Askin proceeds to compare the two systems in a number of ways. He says that the clustered systems represent the same performance as the 3090 machines for 40% less than IBM's price.

But the preclustered systems, says Askins, are designed as upgrades for existing customers. And they will probably be used predominantly as data centers that tie together a disparity of smaller systems. But that in itself could eventually prove a threat to mainframe sales. Says Askins: "Distributed processing is perceived as having value now. There are a lot more people who are computer literate and they don't care where the resources are." In other words, the end user does not care whether it's a mainframe or a supermini or a workstation getting the job done. Concludes Askins: "And the end user is driving the situation." □

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The most profitable companies of 1986

Despite all their complaints, makers of computers and computer products paced the electronics industry last year

By Al Furst and Linda Stallmann

For all their complaints about the slowdown in the computer industry, manufacturers of computers and computer-based systems were among the most profitable companies in the U.S. electronics industry last year.

In 1986, computer companies accounted for 10 of the top 25 most profitable electronics companies in the United States — based on profits and a percentage of sales. The list includes top-ranked supercomputer maker Cray Research Inc., which racked up an impressive 20.9% return on revenue; Altos Computer Systems Inc., No. 5, a multiuser computer vendor which weighed in at 15.1% profit-to-sales ratio; IBM, No. 17, which provided shareholders with $4.7 billion in profits on $51.2 billion in sales for a 9.3% profitability rate, despite relatively flat sales compared with one year earlier; and superminicomputer maker Digital Equipment Corp., No. 25, now IBM's most visible nemesis in the office computer environment.

Computer makers specializing in transaction processing also had nothing to be ashamed of. Both Tandem Computers Inc. (No. 24), the leader in fault-tolerant computers, and challenger Stratus Computer Inc. (No. 12), made it into the top 25 in 1986. Diebold Inc., a leading supplier of computer-based electronic banking systems, checked in at the No. 21 position. And ISC Systems Corp., which also markets automation systems for the banking industry, was No. 23.

Following on the heels of the computer vendors were a slew of disk drive makers specializing in 5.25-inch footprints. The list includes Quantum Corp. (No. 2); Miniscribe Corp. (No. 7); and Micropolis Corp. (No. 19), another leading drive maker.

Also present were firms offering a variety of computer-related products: AST Research Inc., No. 4, which claims to be the leading independent supplier of personal computer enhancement products; Digital Communications Associates Inc. (No. 6),

Computer companies involved in transaction processing were especially profitable in 1986

makers of the ubiquitous Irma board for PC-to-mainframe communications; and Western Digital Corp. (No. 14), which supplies a broad range of storage management and communications controllers, in addition to enhanced peripherals products based on advanced semiconductor technology.

CAD/CAM charisma

While by no means dominant, computer-aided design and manufacturing (CAD/CAM) companies also took a leadership position last year. Intergraph Corp., the red-hot design automation leader from Huntsville, Ala., specializing in mechanical CAD/CAM applications, was No. 8 on our list; Evans & Sutherland Computer Corp., a supplier of high-end CAD/CAM systems for medical, military and miscellaneous applications, was No. 13; Gerber Scientific Inc., a capital equipment supplier with a strong base in the traditional CAD/CAM market, was No. 16; IBM, the undisputed leader in mechanical CAD/CAM (and a dozen other industry segments for that matter) was No. 17; and DEC, another force in CAD/CAM because of its undisputed leadership position in scientific computing, was No. 25.

Connector makers Molex Inc. (No. 10) and AMP Inc. (No. 20) paved the way for the computer segment. But noticeably absent this year from the top of our 1986 profitability chart were semiconductor makers which are still recovering from one of the bloodiest periods in the history of the semiconductor industry. In fact, Analog Devices Inc. and Monolithic Memories Inc. were among the few chip makers to even make it into the top 100 this year.

The award for the most profitably unique company on our list has to go to Cincinnati Microwave Inc. (No. 9), which we list on our table as a communications company. Cincinnati Microwave makes a pocket-sized radar warning system, which is a fancy way of saying "fuzz-buster."

To be considered for inclusion on our list, companies must be publicly held and generate at least 70% of their revenue from electronics. They also must have had at least $100 million in sales in 1986. Software and service companies are not included. ▷

Most profitable electronics companies

Rank	Company	Fiscal 1986 profits as a percentage of revenue	Fiscal 1986 revenue ($ millions)	Fiscal 1986 profits ($ millions)	Fiscal year ended (month/year)	Location
1	Cray Research	20.9%	$596.7	$124.8	12/86	Minneapolis, Minn.
2	Quantum	18.3%	121.2	22.2	3/86	Milpitas, Calif.
3	Medtronic	16.7%	402.8	67.4	4/86	Minneapolis, Minn.
4	AST Research	15.8%	172.3	27.2	6/86	Irvine, Calif.
5	Altos Computer Systems	15.1%	134.2	20.3	6/86	San Jose, Calif.
6	Digital Communications	14.9%	137.9	20.6	6/86	Alpharetta, Ga.
7	MiniScribe	12.3%	184.9	22.7	12/86	Longmont, Colo.
8	Intergraph	11.6%	605.7	70.4	12/86	Huntsville, Ala.
9	Cincinnati Microwave	11.3%	102.1	11.5	12/86	Cincinnati, Ohio
10	Molex	11.0%	291.9	32.0	6/86	Lisle, Ill.
11	Measurex	10.9%	192.7	21.1	11/86	Cupertino, Calif.
12	Stratus Computer	10.9%	124.6	13.5	12/86	Marlboro, Mass.
13	Evans-Sutherland	10.0%	109.3	10.9	12/86	Salt Lake City, Utah
14	Western Digital	9.9%	279.4	27.8	6/86	Irvine, Calif.
15	Telex	9.5%	709.2	67.5	3/86	Tulsa, Okla.
16	Gerber Scientific	9.5%	191.8	18.2	4/86	South Windsor, Conn.
17	IBM	9.3%	51,250.0	4,789.0	12/86	Armonk, N.Y.
18	Electrospace Systems	9.2%	145.0	13.4	3/86	Richardson, Texas
19	Micropolis	8.6%	213.1	18.3	12/86	Chatsworth, Calif.
20	AMP	8.5%	1,933.0	164.0	12/86	Harrisburg, Pa.
21	Diebold	8.4%	413.7	34.9	12/86	Canton, Ohio
22	Pitney Bowes	8.4%	1,986.7	166.1	12/86	Stamford, Conn.
23	ISC Systems	8.3%	166.1	13.9	6/86	Spokane, Wash.
24	Tandem Computers	8.3%	767.8	63.8	9/86	Cupertino, Calif.
25	DEC	8.1%	7,590.4	617.4	6/86	Maynard, Mass.
26	Apple Computer	8.1%	1,901.9	154.0	9/86	Cupertino, Calif.
27	Timeplex	8.0%	119.1	9.6	6/86	Woodcliff Lake, N.J.
28	Loral	8.0%	663.8	53.0	3/86	New York, N.Y.
29	Dynatech	8.0%	256.7	20.4	3/86	Burlington, Mass.
30	Avantek	7.7%	208.2	16.1	12/86	Santa Clara, Calif.
31	Wyse Technology	7.6%	166.4	12.6	3/86	San Jose, Calif.
32	Seagate Technology	7.5%	459.8	34.5	6/86	Scotts Valley, Calif.
33	Xidex	7.5%	432.3	32.2	6/86	Mountain View, Calif.
34	Hewlett-Packard	7.3%	7,102.0	516.0	10/86	Palo Alto, Calif.
35	Emulex	7.1%	104.9	7.5	6/86	Costa Mesa, Calif.
36	Analog Devices	7.0%	334.4	23.4	10/86	Norwood, Mass.
37	NCR	6.9%	4,881.6	336.5	12/86	Dayton, Ohio
38	Data Card	6.9%	153.6	10.6	3/86	Minneapolis, Minn.
39	Symbolics	6.9%	114.2	7.9	6/86	Concord, Mass.
40	COMPAQ Computer	6.9%	625.2	42.9	12/86	Houston, Texas
41	Analogic	6.8%	148.2	10.1	7/86	Peabody, Mass.
42	Watkins-Johnson	6.8%	255.4	17.2	12/86	Palo Alto, Calif.
43	Micom Systems	6.7%	189.5	12.7	3/86	Simi Valley, Calif.
44	Siliconix	6.6%	111.2	7.4	12/86	Santa Clara, Calif.
45	Tandy	6.6%	3,036.0	200.6	6/86	Fort Worth, Texas
46	Bolt Beranek and Newman	6.4%	178.0	11.3	6/86	Cambridge, Mass.
47	Mentor Graphics	6.3%	173.5	11.0	12/86	Beaverton, Ore.
48	MTS Systems	6.3%	109.8	6.9	9/86	Minneapolis, Minn.
49	Adams-Russell Electronics	5.9%	113.1	6.7	9/86	Waltham, Mass.
50	John Fluke	5.8%	209.0	12.2	9/86	Everett, Wash.

Source: ELECTRONIC BUSINESS

(Continued)

Most profitable electronics companies (continued)

Rank	Company	Fiscal 1986 profits as a percentage of revenue	Fiscal 1986 revenue ($ millions)	Fiscal 1986 profits ($ millions)	Fiscal year ended (month/year)	Location
51	Perkin-Elmer	5.6%	$1,290.6	$72.6	7/86	Norwalk, Conn.
52	Prime Computer	5.5%	860.2	46.9	12/86	Natick, Mass.
53	E-Systems	5.4%	1,135.1	61.6	12/86	Dallas, Texas
54	Conrac	5.1%	153.9	7.8	12/86	Stamford, Conn.
55	Aydin	5.1%	136.8	7.0	12/86	Horsham, Pa.
56	Logicon	5.0%	200.5	10.0	3/86	Torrance, Calif.
57	Storage Technology	4.9%	343.1	16.8	12/86	Louisville, Colo.
58	Andrew	4.8%	197.7	9.5	9/86	Orland Park, Ill.
59	AEL Industries	4.5%	104.9	4.7	2/86	Lansdale, Pa.
60	Cipher Data Products	4.4%	163.0	7.2	6/86	San Diego, Calif.
61	Monolithic Memories	4.3%	204.9	8.9	9/86	Santa Clara, Calif.
62	Amdahl	4.3%	966.3	41.8	12/86	Sunnyvale, Calif.
63	California Microwave	4.2%	104.4	4.4	6/86	Sunnyvale, Calif.
64	BRIntec	4.1%	310.7	12.7	12/86	Willimantic, Conn.
65	Decision Industries	4.0%	195.1	7.8	11/86	Horsham, Pa.
66	Gould	3.8%	908.9	34.6	12/86	Rolling Meadows, Ill.
67	Xerox	3.8%	12,900.0	488.0	12/86	Stamford, Conn.
68	Recognition Equipment	3.7%	241.8	9.0	10/86	Irving, Texas
69	DSC Communications	3.6%	304.0	11.0	12/86	Plano, Texas
70	Burr-Brown	3.3%	112.8	3.7	12/86	Tucson, Ariz.
71	Motorola	3.3%	5,888.0	194.0	12/86	Schaumburg, Ill.
72	Applied Magnetics	3.2%	128.1	4.1	9/86	Goleta, Calif.
73	Anthem Electronics	3.0%	104.5	3.1	3/86	San Jose, Calif.
74	Tracor	3.0%	632.1	18.8	12/86	Austin, Texas
75	Systems Industries	3.0%	103.3	3.1	7/86	Milpitas, Calif.
76	SCI Systems	2.9%	470.2	13.8	6/86	Huntsville, Ala.
77	Tektronix	2.9%	1,352.2	39.3	5/86	Beaverton, Ore.
78	Triad Systems	2.8%	111.7	3.2	9/86	Sunnyvale, Calif.
79	Diasonics	2.7%	217.1	5.9	12/86	Milpitas, Calif.
80	Harris	2.7%	2,216.6	59.6	6/86	Melbourne, Fla.
81	Apollo Computer	2.4%	391.7	9.3	12/86	Chelmsford, Mass.
82	Emerson Radio	2.3%	566.3	12.9	3/86	North Bergen, N.J.
83	Nicolet Instruments	2.3%	126.4	2.9	3/86	Madison, Wis.
84	General DataComm Industries	2.2%	178.0	3.9	9/86	Middlebury, Conn.
85	LSI Logic	2.0%	194.3	3.9	12/86	Milpitas, Calif.
86	Wang Laboratories	1.9%	2,643.0	50.9	6/86	Lowell, Mass.
87	Rogers	1.8%	128.8	2.3	12/86	Rogers, Conn.
88	N.A. Philips	1.8%	4,531.6	81.2	12/86	New York, N.Y.
89	Avnet	1.7%	1,415.6	23.9	6/86	New York, N.Y.
90	Wyle Laboratories	1.4%	307.0	4.3	1/87	El Segundo, Calif.
91	Coherent	1.3%	138.2	1.7	9/86	Palo Alto, Calif.
92	Marshall Industries	1.2%	244.8	2.9	5/86	El Monte, Calif.
93	Sun Electric	1.1%	177.0	1.9	10/86	Crystal Lake, Ill.
94	Compugraphic	1.0%	341.1	3.4	12/86	Wilmington, Mass.
95	Applied Materials	0.8%	149.3	1.2	10/86	Santa Clara, Calif.
96	Texas Instruments	0.8%	4,970.0	39.9	12/86	Dallas, Texas
97	Key Tronic	0.5%	111.7	0.6	6/86	Spokane, Wash.
98	Data General	0.5%	1,268.0	5.7	9/86	Westboro, Mass.
99	Spectra-Physics	0.4%	210.1	0.8	9/86	San Jose, Calif.
100	Cubic	0.3%	337.8	1.1	9/86	San Diego, Calif.

Source: ELECTRONIC BUSINESS

(Continued)

Most profitable electronics companies by industry segment

Capital equipment

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Gerber Scientific	9.5%	16
Hewlett-Packard	7.3%	34
John Fluke	5.8%	50
Perkin-Elmer	5.6%	51
Tracor	3.0%	74
Tektronix	2.9%	77
Nicolet Instruments	2.3%	83
Applied Materials	0.8%	95
Spectra-Physics	0.4%	99
Weighted average	**6.1%**	

Communications

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Digital Communications	14.9%	6
Cincinnati Microwave	11.3%	9
Timeplex	8.0%	27
Dynatech	8.0%	29
Avantek	7.7%	30
Micom Systems	6.0%	43
Bolt Beranek and Newman	6.4%	46
Adams-Russell Electronics	5.9%	49
Andrew	4.8%	58
California Microwave	4.2%	63
DSC Communications	3.6%	69
Motorola	3.3%	71
General DataComm Industries	2.2%	84
Weighted Average	**4.2%**	

Components

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Molex	11.0%	10
Western Digital	9.9%	14
AMP	8.5%	20
Analog Devices	7.0%	36
Siliconix	6.6%	44
Monolithic Memories	4.3%	61
BRIntec	4.1%	64
Burr-Brown	3.3%	70
Motorola	3.3%	71
LSI Logic	2.0%	85
Rogers	1.8%	87
Texas Instruments	0.8%	96
Weighted average	**3.5%**	

Computers

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Cray Research	20.9%	1
Altos Computer Systems	15.1%	5
Stratus Computer	10.9%	12
Telex	9.5%	15
IBM	9.3%	17
Tandem Computers	8.3%	24
DEC	8.1%	25
Apple Computer	8.1%	26
Hewlett-Packard	7.3%	34
NCR	6.9%	37
Symbolics	6.9%	39
COMPAQ Computer	6.9%	40
Analogic	6.8%	41
Tandy	6.6%	45
Prime Computer	5.5%	52
Amdahl	4.3%	62
SCI Systems	2.9%	76
Apollo Computer	2.4%	81
Texas Instruments	0.8%	96
Data General	0.5%	98
Weighted average	**8.1%**	

Defense electronics

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Electrospace Systems	9.2%	18
Loral	8.0%	28
Watkins-Johnson	6.8%	42
E-Systems	5.4%	53
Aydin	5.1%	55
Logicon	5.0%	56
AEL Industries	4.5%	59
Motorola	3.3%	71
Harris	2.7%	80
Texas Instruments	0.8%	96
Cubic	0.3%	100
Weighted average	**2.9%**	

Distributors

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Anthem Electronics	3.0%	73
Emerson Radio	2.3%	82
Avnet	1.7%	89
Wyle Laboratories	1.4%	90
Marshall Industries	1.2%	92
Weighted average	**1.8%**	

Computer-based systems

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Intergraph	11.6%	8
Measurex	10.9%	11
Evans-Sutherland	10.0%	13
Diebold	8.4%	21
ISC Systems	8.3%	23
Hewlett-Packard	7.3%	34
Data Card	6.9%	38
MTS Systems	6.3%	48
Recognition Equipment	3.7%	68
Triad Systems	2.8%	78
Coherent	1.3%	91
Sun Electric	1.1%	93
Compugraphic	1.0%	94
Weighted average	**7.1%**	

Peripherals

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Quantum	18.3%	2
AST Research	15.8%	4
MiniScribe	12.3%	7
Micropolis	8.6%	19
Wyse Technology	7.6%	31
Seagate Technology	7.5%	32
Xidex	7.5%	33
Emulex	7.1%	35
Conrac	5.1%	54
Storage Technology	4.9%	57
Cipher Data Products	4.4%	60
Decision Industries	4.0%	65
Applied Magnetics	3.2%	72
Systems Industries	3.0%	75
Key Tronic	0.5%	97
Weighted average	**7.4%**	

Office equipment

Company	Fiscal 1986 profits as a percentage of revenue	Rank
IBM	9.3%	17
Pitney Bowes	8.4%	22
NCR	6.9%	37
Xerox	3.8%	67
Harris	2.7%	80
Wang Laboratories	1.9%	86
Weighted average	**7.8%**	

Source: ELECTRONIC BUSINESS